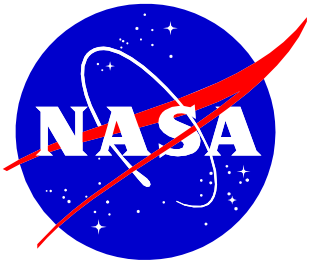
GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT

Large Area Telescope (LAT) - GLAST Burst Monitor (GBM) Burst Telecommand & Alert Telemetry INTERFACE CONTROL DOCUMENT

March 4, 2004



GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

GAMMA-RAY LARGE AREA SPACE TELESCOPE
(GLAST)
PROJECT

LAT - GBM

Burst Telecommand & Alert Telemetry

INTERFACE CONTROL DOCUMENT (ICD)

March 4, 2004

NASA Goddard Space Flight Center
Greenbelt, Maryland

GLAST PROJECT LAT-GBM ICD (1 of 2)

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LIST OF ACRONYMS AND ABBREVIATIONS

ACS	Attitude Control Subsystem
ARR	Autonomous Repoint Request
CCSDS	Consultative Committee for Space Data Systems
CDRL	Contract Deliverable Requirements List
DAQ	Digital Acquisition Unit
DEC	Declination
DOE	Department Of Energy
DPU	Data Processing Unit (GBM)
EGSE	Electronic Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPS	Electrical Power Subsystem
FEM	Finite Element Model
FOV	Field of View
GASU	Global Trigger-ACD-Signals Unit (LAT)
GBM	GLAST Burst Monitor
GEVS	General Environmental Verification Specification For STS & ELV
GFE	Government Furnished Equipment
GHz	Gigahertz
GLAST	Gamma-ray Large Area Space Telescope
GRB	Gamma Ray Burst
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GT_PDU	GLAST Telemetry Protocol Data Unit
HW	Hardware
Hz	Hertz
I&T	Integration and Test
ICD	Interface Control Document
ICN	Interface Change Notice
IPO	Instrument Program Office
IRD	Interface Requirements Document
ITAR	International Traffic in Arms Regulation
ITS	Immediate Trigger Signal
KHz	Kilohertz
LAT	Large Area Telescope
LSB	Least Significant Bit
MIL-HDBK	Military Handbook

MRD	Mission Requirements Document
MSB	Most Significant Bit
MSFC	Marshall Space Flight Center
ms	Milliseconds
NASA	National Aeronautics and Space Administration
OAP	Orbit Average Power
OB	Optical Bench
PDU	Power Distribution Unit
IRR	Integration Readiness Review
PRU	Power Regulation Unit
PSR	Pre-Ship Review
RA	Right Ascension
RF	Radio Frequency
SC	Spacecraft
SIU	Spacecraft Interface Unit
SLAC	Stanford Linear Accelerator Center
SNR	Signal-to-Noise Ratio
SOH	State-of-Health
SOW	Statement of Work
STDN	Space Tracking and Data Network
STP	System Test Plan
SW	Software
TBD	To Be Determined
TBR	To Be Reviewed/Revised
TBS	To Be Specified
TC	Telecommand
TDRSS	Tracking and Data Relay Satellite System
TLM	Telemetry
usec	Microsecond
Vdc	Volts DC

1 INTRODUCTION

There exists interaction between the two instruments on the NASA's Gamma-ray Large Area Space Telescope (GLAST). The Large Area Telescope (LAT), the high-energy instrument on the GLAST Observatory, and the GLAST Burst Monitor, the lower-energy instrument, communicate across a dedicated communication link and a MIL-STD-1553B bus when Gamma Ray Bursts (GRBs) trigger one (or both) of the instruments. These burst-related interfaces between the LAT and the GBM are defined in this document. Additionally, the Alert Telemetry generated in the context of GRBs is captured in this document.

The LAT will be designed, fabricated and fully tested by the Stanford Linear Accelerator Center (SLAC) and its international team of partners, under sponsorship of NASA and the Department Of Energy (DOE).

The GBM will be designed, fabricated and fully tested by the Marshall Space Flight Center (MSFC) and its international team of cooperating institutions.

Both fully tested instruments will be provided as Government Furnished Equipment (GFE) to Spectrum Astro for integration onto the Spacecraft (SC) bus to form the GLAST Observatory. It is during the Observatory Integration and Test phase that the LAT and GBM instruments will verify, by formal testing, the interfaces defined herein.

1.1 PURPOSE

The purpose of this Interface Control Document (ICD) is to coordinate and control all interface items between the GBM and the LAT to provide efficient electrical integration and ensure compatibility between the instruments. Additionally this ICD addresses the sharing of the TDRS link resource during times of Gamma Ray Bursts. The ICD will ensure successful integration between the GBM and LAT on the GLAST Observatory by documenting the functional interfaces required to achieve installation, checkout, and orbital mission objectives. Approval of this document by the responsible signatories shall certify that:

a. This ICD establishes the controlled LAT-GBM interface requirements.

b. The LAT and GBM shall meet the integration, testing, and operations requirements and constraints specified.

1.2 SCOPE

This document contains specific interface requirements for both the LAT and the GBM to be flown on GLAST. Graphics are used as appropriate to define the interface requirements and data flow. For the GBM components, details of the mechanical interface are captured in the following location:

a. GBM-SC ICD: Appendix C. Data Processing Unit (DPU) – Interface Drawing

For the LAT components, details of the electrical-mechanical interface are captured in the following location

b. LAT-SC ICD: Appendix B. LAT Electrical Pinouts

This ICD delineates the responsibilities of SLAC as LAT provider and MSFC as GBM provider by defining burst-related electrical and data interfaces.

1.3 RELATIONSHIP TO OTHER DOCUMENTS

Each instrument interfaces primarily with the GLAST spacecraft bus. These interfaces are documented in the respective Instrument-Spacecraft ICD.

- The LAT: 1196 EI-Y46311-000 – LAT to SC Interface Control Document
- The GBM: 1196 EI-Y46312-000 – GBM to SC Interface Control Document

Communications protocols on the 1553 bus are documented in the 1553 Bus Protocol ICD:

1196 EI-S46310-000 Rev -;1553B Bus Protocol Interface Control Document;

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Unless otherwise specified, the following documents in their current issue form a part of this document to the extent specified herein. Unless otherwise specified, the latest document version that is in effect shall apply.

433-SRD-0001, GLAST Science Requirements Document,

433-SPEC-0003, GLAST Spacecraft Performance Specification

433-SPEC-0001, GLAST Mission System Specification

433-IRD-0001, LAT Instrument-SC Interface Requirements Document

433-IRD-0002, GBM Instrument-SC Interface Requirements Document

433-MAR-0001, LAT Mission Assurance Requirements Document

433-MAR-0002, GBM Mission Assurance Requirements Document

433-MAR-0003, Spacecraft Mission Assurance Requirements Document

LAT-SS-00399, GLAST LAT Flight Software Specification – Level IV

GBM-REQ-1019, GBM FLIGHT SOFTWARE Requirements Specification

433-RQMT-0005, GLAST Satellite Electromagnetic Interference (EMI) Requirements Document

Mil-STD-1553B, “Aircraft Internal Time Division Command/Response Multiplex Data Bus”, 21 September, 1978

NPD 8010.2C, Use of the Metric System of Measurement in NASA programs

2.2 REFERENCE DOCUMENTS

Requirements in this Specification reference the following documents:

433-OPS-0001, GLAST Operations Concept Document

3 BURST INTERFACES

The LAT in concert with the GBM will measure the energy spectra of GRBs from a few keV to hundreds of GeV during the short time after onset when the vast majority of the energy is released.

Additionally, the GLAST Observatory will promptly alert other observers, thus allowing the observations of GLAST to be placed in the context of multiwavelength afterglow observations.

To accomplish these goals the following inter-instrument interfaces have been designed onto the GLAST Observatory. Note that additional burst-related interfaces between the Spacecraft and the LAT instrument (Auto Repoint Request and its Response) are documented in detail in the LAT-SC ICD. All GBM-related burst interfaces are captured in this document. Where interfaces to the spacecraft exist in the context of a burst related sequence, these interfaces will be referenced, but not detailed.

3.1 IMMEDIATE TRIGGER SIGNAL (ITS)

Following on the successful heritage of direct communications between the EGRET and BATSE instruments on the Compton Gamma Ray Observer satellite, GLAST has designed into the observatory, a cross-strapped “Immediate Trigger Signal”. Additionally, this trigger signal provides future flexibility allowing for yet-to-be discovered phenomena which can be readily and immediately acted upon if so warranted.

3.1.1 ELECTRICAL CHARACTERISTICS

The Immediate Trigger Signal shall be a one-way notification signal from the GBM instrument to the LAT instrument.

The Immediate Trigger Signal pulse shall be negative logic, (falling edge) with a minimum duration of 0.25 microseconds.

3.1.2 SIGNAL CHARACTERISTICS

The GBM shall send a single pulse to the LAT for each burst trigger in the GBM. The GBM sends signals to both LAT Primary and Redundant (one of which will be powered off) to ensure that the active LAT side receives the signal.

The Immediate Trigger Signal shall be sent no more frequently than once every 10 seconds.

The Immediate Trigger Signal interface transmitters and receivers shall use LVDS drivers and receivers compatible with IEEE 1596.3SCI LVDS and be compatible with ANSI/TIA/EIA 644-1996 LVDS standards.

A schematic of the Immediate Trigger Signal is shown in Figure 3-1. Primary and redundant interfaces shall be identical.

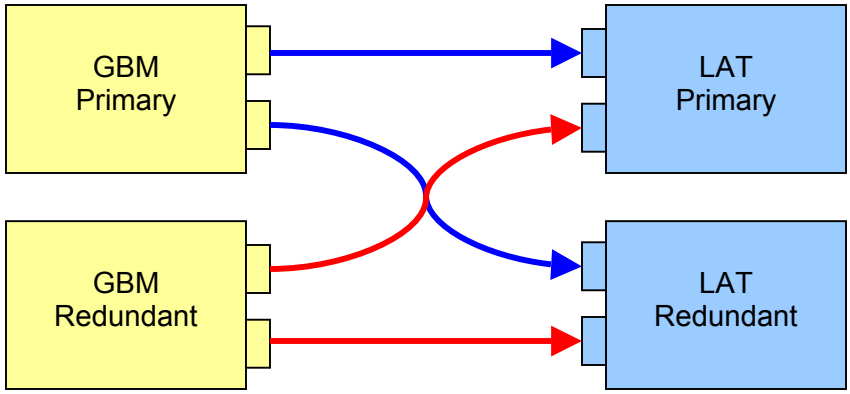

Figure 3-1: Immediate Trigger Redundant Topology

The LAT shall have a 100 Ohm terminator on the differential input signals as shown in Figure 3-2.

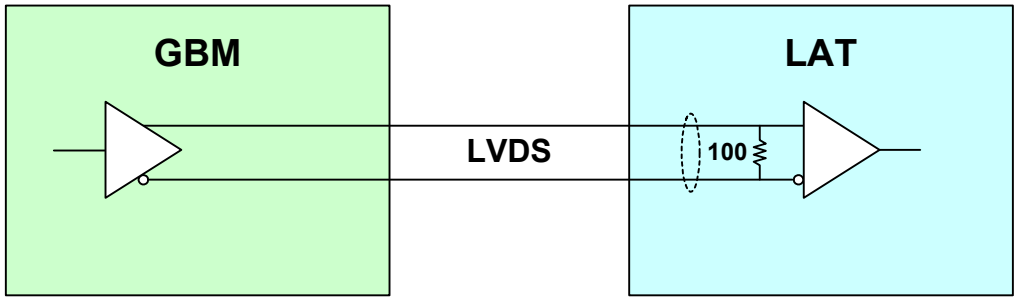

Figure 3-2: Immediate Trigger Signal Circuit

3.1.3 IMMEDIATE TRIGGER SIGNAL WIRE PROVIDER

The Spacecraft Vendor, as Observatory Integrator, shall provide the physical wire and wiring required to connect the LAT GASUs and GBM DPUs.

3.2 INTER INSTRUMENT TELECOMMANDS

Upon reaching predefined (and settable) threshold levels, the LAT and/or the GBM instruments will 'trigger'. When either instrument triggers, it will communicate using telecommands across the MIL-STD-1553B (ie. 1553) bus to the other instrument, as well as providing data to the spacecraft for telemetering to the ground. All relevant details of the 1553 bus architecture, schedule, and implementation as well as telecommand and telemetry packet structure, are described in document 1553 Bus Protocol ICD (1196-EI- S46310-000).

The spacecraft performs the role of Bus Controller. The instruments are Remote Terminals on the 1553 bus. A diagram of the 1553 bus topology is shown in Figure 3-3.

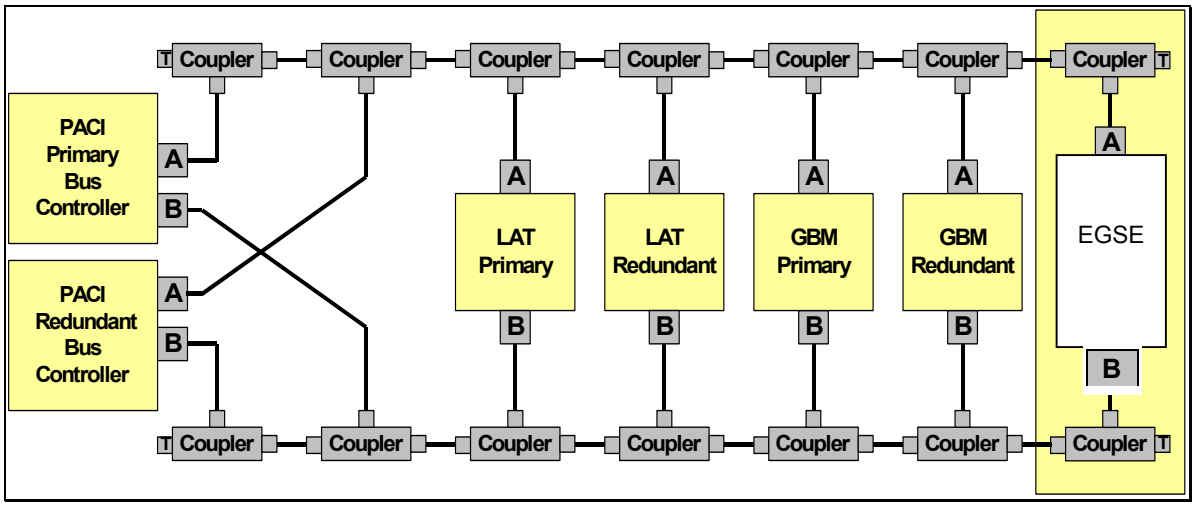

Figure 3-3: 1553 Bus Topology

3.2.1 GBM TELECOMMANDS TO LAT

The information the GBM plans to provide to the LAT is documented within the following telecommands.

Pursuant to agreements which are documented in the 1553 ICD (Ref 1196-EI-S46310-000), telecommand packets have a maximum length of 62 bytes, of which 10 bytes are used for Primary and Secondary Headers, and for a checksum. In no case shall a telecommand span across more than one packet. Telecommands contain an even number of bytes.

3.2.1.1 GBM "Calculated Information" Telecommand

The GBM shall be capable of issuing this telecommand periodically during a burst sequence to the LAT. It contains the best available calculated location and reliability parameters. The contents of this message are defined below in Table 3-1.

Table 3-1: Calculated Information (TRIGDAT 11) Telecommand Fields

G2LCALCINFO	Calculated Information Telecommand. The GBM shall provide this information up to five times to the LAT subsequent to triggering.	
	Telecommand APID: 0x660; Function Code: 1; Length: 46 bytes	
	PACKET HEADER	Type: 6 bytes; 48 bits CCSDS telecommand packet header. See 1553 ICD, Section 4.3.1.
	SECONDARY HEADER	Type: 2 bytes; 16 bits Secondary telecommand packet header. See 1553 ICD, Section 4.3.1.
	TRIGGER ID	Type: 6 bytes; 48-bits, defined as follows: ID of the burst. All telecommands relating to this burst will have the same TriggerID. This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 bytes; 8-bit unsigned big-endian int. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst.
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian int. Record Type Version Number
	LOCATION RA	Type: 2 bytes; 16-bit big-endian integer; Calculated Location: Right Ascension
	LOCATION DEC	Type: 2 bytes; 16-bit big-endian integer; Calculated Location Declination
	STAT ERROR	Type: 2 bytes: 16-bit big-endian integer; Statistical Error on location.
	LOCATION ALGORITHM	Type: 2 bytes: 16-bit big-endian integer; Location algorithm used (many spare bits)
	CLASSIFICATION AND RELIABILITY	Type: 4 bytes; 4 8-bit unsigned big-endian int; Classification and reliability of classification.
	REASON FOR TRIGGER	Type: 16 bytes; 16 8-bit values. Will include timescale and energy band. Details tbd.
	CHECKSUM	Type: 2 bytes; 16-bit unsigned big-endian int. Modulo 65536 addition of each byte in telecommand, excluding checksum.

Note: This telecommand shall be sent to the LAT up to five times.
Note 2: Should the GBM determine that the burst merits a repointing recommendation, it will send the “Candidate Repoint Request” Telecommand to the LAT and suppress all other “Calculated Information” TCs.

3.2.1.2 GBM Candidate Repoint Recommendation Telecommand

The Candidate Repoint Recommendation telecommand is sent once per burst trigger.
.

Table 3-2: Candidate Repoint Recommendation (TRIGDAT12) Telecommand Fields

G2LCREPREC	Candidate Repoint Recommendation Telecommand. The GBM shall provide exactly one of these telecommands for each burst trigger.	
	Telecommand APID: 0x660; Function Code: 2; Length: 28 bytes	
	PACKET HEADER	Type: 6 bytes (48 bits) CCSDS telecommand packet header. See 1553 ICD, Section 4.3.1
	SECONDARY HEADER	Type: 2 bytes (16 bits). Secondary telecommand packet header. See 1553 ICD, Section 4.3.1
	TRIGGER ID	Type: 6 bytes; 48-bits, defined as follows: ID of the burst. All telecommands relating to this burst will have the same TriggerID. . This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	LAT RECORD SEQUENCE NUM	Type: 1 byte; 8-bit unsigned big-endian int. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst.
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian int. Record Type Version Number
	FILL	Type: 1 byte; 8-bit unsigned int. Fill = 0.
	REPOINT RECOMMENDATION	Type: 1 byte; 8-bit unsigned big-endian int. 0 = Recommend Repoint; 1 = Do Not Recommend Repoint
	LOCATION RA	Type: 2 bytes; 16-bit big-endian integer; Calculated Location: Right Ascension
	LOCATION DEC	Type: 2 bytes; 16-bit big-endian integer; Calculated Location Declination
	STAT ERROR	Type: 2 bytes: 16-bit big-endian integer; Statistical Error on location.
	LOCATION ALGORITHM	Type: 2 bytes: 16-bit big-endian integer; Location algorithm used (many spare bits)
	CHECKSUM	Type: 2 bytes; 16-bit unsigned big-endian int. Modulo 65536 addition of each byte in telecommand, excluding checksum.

3.2.1.3 GBM Closeout Telecommand

The GBM Closeout telecommand is sent once per burst trigger.

Table 3-3: GBM Closeout Telecommand Fields

G2LCLOSEOUT	GRB Closeout Telecommand. The GBM shall provide exactly one of these telecommands for each burst trigger. It will be the LAST message sent about any particular burst.	
	Telecommand APID: 0x660; Function Code: 3; Length: 18 bytes	
	PACKET HEADER	Type: 6 bytes (48 bits) CCSDS telecommand packet header. See 1553 ICD, Section 4.3.1
	SECONDARY HEADER	Type: 2 bytes (16 bits). Secondary telecommand packet header. See 1553 ICD, Section 4.3.1
	TRIGGER ID	Type: 6 bytes; 48-bits, defined as follows: ID of the burst. All telecommands relating to this burst will have the same TriggerID. . This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	LAT RECORD SEQUENCE NUM	Type: 1 byte; 8-bit unsigned big-endian int. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst.
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian int. Record Type Version Number
	CHECKSUM	Type: 2 bytes; 16-bit unsigned big-endian int. Modulo 65536 addition of each byte in telecommand, excluding checksum.

3.2.1.4 GBM Initiated Immediate Trigger Signal and Telecommand Timing

Within the GBM, only one Gamma Ray Burst trigger can be 'active' at any given time. Once the GBM triggers, there will be no other GRB triggers until the sequence of telecommands described has completed.

The GBM shall send the following information to the LAT upon a GRB trigger,

- One (1) Immediate Trigger Signal (within 5 ms of burst recognition).
- Up to five (5) G2LCALCINFO telecommands.
- One (1) G2LCREPREC telecommand signifying whether or not this GRB is a candidate for Repointing.
- One (1) G2LCLOSEOUT telecommand signifying end of messages associated with this burst (within 600 seconds of burst recognition)."

The 1553 Telecommand timing

- The G2LCALCINFO (Calculated Information) Telecommand (TRIGDAT Record Type 11) is sent at approximately 0.2 seconds, 1.8 seconds, 5 seconds, 30 seconds and 100 seconds after the GBM triggers. At any time, if the burst is deemed worthy of a repoint request, the GBM shall immediately issue the Candidate Repoint Recommendation.

- The G2LCREPREC (Candidate Repoint Recommendation) Telecommand (TRIGDAT Record Type 12) is generated exactly once for every GBM Trigger. Starting at 2 s post GBM trigger, GBM FSW will evaluate the classification and intensity of the event. As soon as the repoint criteria are satisfied, a positive Candidate Repoint Recommendation will be issued. If the criteria are not satisfied by end of GBM Triggered Mode (nominal duration 600 s), a negative Candidate Repoint Recommendation telecommand will be issued. A negative Candidate Repoint Recommendation may be issued earlier if the event is reliably classified as not originating from a GRB.

- The G2LCLOSEOUT (GBM Closeout) Telecommand is generated exactly once for every GBM Trigger. This will occur either at the Burst Timeout Value (nominally 600 seconds) or when the GRB has been determined to be uninteresting.

3.2.2 LAT TELECOMMANDS TO GBM

Just as with the GBM, whenever a burst is detected, and predefined criteria are met, the LAT will send information to the ground and the GBM outside the standard science data path. The LAT will send a subset of the total information to the GBM for two reasons. First, so the GBM is aware that the 1 kbps downlink channel resource is being shared between the instruments and second, so GBM can choose to modify its data collection algorithms and/or preserve its buffered science data for recording to the SSR in the event it does not recognize or trigger on the burst.

3.2.2.1 Packet Definitions

A burst detection meeting the alert criteria will cause the LAT to send data in two different telecommand types:

1. L2GLATTRIGGER (one per burst alert)
2. L2GLATCLOSEOUT (one per burst alert)

For a LAT-detected burst alert, the LAT shall issue one L2GLATTRIGGER telecommand packet (sister packet to the L2GLATTRIGGER Alert Telemetry packet described in Chapter 4, Table 4-12) to the GBM. Only one L2GLATTRIGGER telecommand is sent per burst. The LATTRIGGER telecommand is described in Table 3-4.

For a LAT-detected burst alert, LAT shall issue one L2GLATCLOSEOUT telecommand packet to the GBM. (This is the sister packet to the LATCLOSEOUT alert telemetry packet, as described in Chapter 4, Table 4-14.) The L2GLATCLOSEOUT shall be formatted as a telecommand and sent to the GBM as described in Table 3-5. The L2GLATCLOSEOUT shall be issued after a predetermined time period of below-threshold detection (a LAT configuration parameter) of at least one minute (or non-detection; this time period is not likely to exceed 10 minutes).

Once a L2GLATTRIGGER telecommand is issued, no further L2GLATTRIGGER telecommands shall be issued until after a L2GLATCLOSEOUT telecommand is issued[1].

3.2.2.2 Generic Telecommand Field Descriptions

For simplicity, the header information format for LAT generated telecommands and telemetry packets is the same for all record types.

[1] One possible exception to this is when the LAT is reset or power-cycled after a Trigger Record has been sent but before the Closeout Record has been sent. GBM and the ground system will probably want to know about such occurrences.

3.2.2.3 L2GLATTRIGGER Telecommand

One L2GLATTRIGGER telecommand per burst is sent to the GBM (and a corresponding Alert Telemetry Packet is sent to the ground).

Table 3-4: L2GLATTRIGGER Telecommand

L2GLATTRIGGER	**The LAT shall provide this telecommand to the GBM when it has triggered on a burst**	
	Telecommand APID: x6F1; Function Code: 1; Length: 22 bytes	
	Packet Header	Type: 6 bytes; CCSDS telecommand packet header See 1553 ICD; Section 4.3.1 –, TC Format Spec
	Secondary Header	Type: 2 bytes; Secondary telecommand packet header See 1553 ICD, Section 4.3.1 –TC Format Spec
	Time-seconds	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst). Serves as Burst ID.
	Time-microsec	Type: 4 bytes; 32 bit big-endian unsigned integer TheLAT specified burst “declaration time” (identical in all packets related to the same burst).
	Burst Classification	Type: 4 bytes, defined as follows: Detailed Content TBD. Information, e.g., is this a repoint candidate, etc.
	Checksum	Type: 2 bytes; 16-bit unsigned big-endian integer. Modulo 65536 addition of each byte in telecommand, excluding checksum

3.2.2.4 L2GLATCLOSEOUT Telecommand

One L2GLATCLOSEOUT Telecommand per burst is sent to the GBM.
Note: A corresponding Alert Telemetry packet (see Section 4.2.4) is sent to the SC for transmission to the ground.

Table 3-5: L2GLATCLOSEOUT Telecommand

L2GLATCLOSEOUT	**The LAT shall provide this telecommand to the GBM when it closes its burst processing for the specified burst.**	
	Telecommand APID: x6F1; Function Code: 3; Length: 22 bytes	
	Packet Header	Type: 6 bytes; CCSDS telecommand packet header See Section 4.3.1 – 1553 ICD, TC Format Spec
	Secondary Header	Type: 2 bytes; CCSDS telecommand secondary header See Section 4.3.1 – 1553 ICD, TC Format Spec
	Time-seconds	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst "declaration time" (identical in all packets related to the same burst). Serves as Burst ID.
	Time-microsec	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst "declaration time" (identical in all packets related to the same burst).
	Burst Classification	Type: 4 bytes; defined as follows: Detailed Content TBD. Information, *e.g.*, was this a repoint candidate, etc.
	Checksum	Type: 2 bytes; 16-bit unsigned big-endian integer. Modulo 65536 addition of each byte in telecommand, excluding checksum

4 BURST ALERT TELEMETRY

In addition to information passing between the instruments, notification of ground based systems and users is critical to the success of burst observation by other platforms.

4.1 GBM GENERATED BURST ALERT TELEMETRY (TRIGDAT RECORD TYPES)

The GBM produces several TRIGger DATa (TRIGDAT) records which are telemetered to the ground at calculated intervals. The details of these Alert Telemetry Packets is contained in the following sections.

Note: GBM Burst Alert Telemetry Packets may have secondary header times that are not in order.

4.1.1 IMMEDIATE SUMMARY INFORMATION

Purpose: Provides the most current “Immediate” Summary Information

Table 4-1: Immediate Summary Information Alert Telemetry

TrigDat01	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x541; Length: 38 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID)
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified ‘TRIGGER ID’ burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	TRIGGER ALGORITHM	Type: 16 bytes; defined as follows: Trigger scheme that triggered, including timescale & energy band.
	DETECTORS	Type: 2 bytes; defined as follows: Detectors that initiated the trigger

4.1.2 TRIGGER RATES

Purpose: Provides the Trigger Rates in each detector.

Table 4-2: Trigger Rate Alert Telemetry

TrigDat02	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x542; Length: 266 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	SC ATTITUDE	Type: 22 bytes; (176 bits) defined as follows: S/C Attitude Quaternion (4 X 32 bits) and ECI Position (3 X 16 bits)
	RATES	Type: 224 bytes; (1792 bits) defined as follows: rates on trigger timescale/energy band, 14 detector X 8 channels X 16 bits

4.1.3 BACKGROUND RATES (AT TRIGGER TIME)

Purpose: Calculated Information from the DPU.

Table 4-3: Trigger Time Background Rates Alert Telemetry

TrigDat03	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x543; Length: 246 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	QUALITY FLAG	Type: 2 bytes; defined as follows: Quality Flag bits for the background model.
	BACKGROUND RATES	Type: 224 bytes; (1792 bits) defined as follows: background rates: 14 det X 8 chan X 16 bits

4.1.4 CALCULATED INFORMATION

Purpose: Calculated Information from the DPU.

Table 4-4: Calculated Information Alert Telemetry

TrigDat04	**The GBM shall provide this Alert Telemetry up to 5 times per burst**	
	Telemetry APID: x544; Length: 62 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	LOCATION RA	Type: 2 bytes; 16-bit big-endian integer; Calculated Location: Right Ascension
	LOCATION DEC	Type: 2 bytes; 16-bit big-endian integer; Calculated Location Declination
	STAT ERROR	Type: 2 bytes: 16-bit big-endian integer; Statistical Error on location.
	LOCATION ALGORITHM	Type: 2 bytes: 16-bit big-endian integer; Location algorithm used (many spare bits)
	EVENT CLASS	Type: 4 bytes; defined as follows: Event classification and reliability estimate thereof
	SPECTRAL PARAMS	Type: 30 bytes; defined as follows: peak flux (2 timescales X 3 ebands), fluence (3 ebands), perhaps Band GRB parameter values, perhaps error estimates on some of the values

4.1.5 MAX RATES

Purpose: Provide Max Rates experienced during the burst period.

Note: The Max Rates are for the timescale and energy band with the best Signal-to-Noise Ratio (SNR). The Secondary Header gives the end time of the interval during which max rates were searched for. The application data contains the end time of the interval with the maximum rates.

Table 4-5: Max Rates Alert Telemetry

TrigDat05	**The GBM shall provide this Alert Telemetry up to 3 times per burst**	
	Telemetry APID: x545; Length: 274 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	SC ATTITUDE	Type: 22 bytes; (176 bits) defined as follows: S/C Attitude Quaternion (4 X 32 bits) and ECI Position (3 X 16 bits)
	TIME-ENERGY BAND RATES	Type: 2 bytes; (16 bits) defined as follows: Timescale of the rates
	MAX RATE TIME	Type: 6 bytes. Ending time of the interval with the maximum rate
	MAX RATES	Type: 224 bytes; (1792 bits) defined as follows: max rates: 14 detectors X 8 channels X 16 bits

4.1.6 BACKGROUND MODEL I – PART 1 (OF 3)

Purpose: Provides Background Model parameters at the time of the trigger.

Note: (1) The background model parameters are referenced to the time t_b which is given in the secondary header:

$b = a_2 * (t - t_b)**2 + a_1 * (t - t_b) + a_0$.

Note (2): Part 1 contains the lowest order coefficients, a_0, of the quadratic models -- the constant terms.

Note (3): The background model quality flag bits are included in Record Type 3, Background Rates.

Table 4-6: Background Model (1 of 3) Alert Telemetry

TrigDat06	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x546; Length: 244 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	BACKGROUND MODEL PARAMS	Type: 224 bytes; (1792 bits) defined as follows: background model parameters: a_0 terms: 14 detectors X 8 channels X 16 bits

4.1.7 BACKGROUND MODEL II – PART 2 (OF 3)

Purpose: Provides Background Model parameters at the time of the trigger.

Note: (1) The background model parameters are referenced to the time t_b which is given in the secondary header:

$b = a_2 * (t - t_b)**2 + a_1 * (t - t_b) + a_0$.

Note (2): Part 2 contains the first order coefficients, a_1, of the quadratic models -- the linear terms.

Table 4-7: Background Model (2 of 3) Alert Telemetry

TrigDat07	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x547; Length: 244 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	BACKGROUND MODEL PARAMS	Type: 224 bytes; (1792 bits) defined as follows: background model parameters: a_1 terms: 14 detectors X 8 channels X 16 bits

4.1.8 BACKGROUND MODEL III – PART 3 (OF 3)

Purpose: Provides Background Model parameters at the time of the trigger.

Note: (1) The background model parameters are referenced to the time t_b which is given in the secondary header:

$b = a_2 * (t - t_b)**2 + a_1 * (t - t_b) + a_0$.

Note (2): Part 3 contains the second order coefficients, a_2, of the quadratic models -- the quadratic terms.

Table 4-8: Background Model (3 of 3) Alert Telemetry

TrigDat08	**The GBM shall provide this Alert Telemetry 1 time per burst**	
	Telemetry APID: x548; Length: 244 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	BACKGROUND MODEL PARAMS	Type: 224 bytes; (1792 bits) defined as follows: background model parameters: a_2 terms: 14 detectors X 8 channels X 16 bits

4.1.9 TIME HISTORY

Purpose: Provides Time History (for ground calculation of location/spectrum/intensity)

Table 4-9: Time History Alert Telemetry

TrigDat09	**The GBM shall provide this Alert Telemetry up to 124 times per burst**	
	Telemetry APID: x549; Length: 266 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 6 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header
	TRIGGER ID	Type: 6 bytes. 48 bits ID of the burst. All telemetry relating to this burst will have the same TriggerID). This is also the time. 32 bits (unsigned int) of tenths of seconds and 16 bits (unsigned int) where LSB is 2 usec.
	RECORD SEQUENCE NUM	Type: 1 byte. 8-bit unsigned big-endian integer. Record number (1 relative) with respect to the specified 'TRIGGER ID' burst
	RECTYPE VERSION NUMBER	Type: 1 byte; 8-bit unsigned big-endian integer. Record Type Version Number
	SC ATTITUDE	Type: 22 bytes; (176 bits) defined as follows: S/C Attitude Quaternion (4 X 32 bits) and ECI Position (3 X 16 bits)
	RATES	Type: 224 bytes; (1792 bits) defined as follows: max rates: 14 det X 8 chan X 16 bits

Note: The Secondary header gives the ending time of the data accumulation. These records are not sent in the order of their secondary headers.

Table 4-10: Time resolutions and Coverage for Time History

Nominal Time Range(s)	Nominal Resolution	Sub Record Type	Number Of Records	Actual TIme Range(s)
-130 to -2	8	a	17	-133.12 to -2.048
-1 to +2	¼	b	13	-1.024 to 2.048
-2 to +22	1	c	25	-2.048 to 22.528
+22 to +470	8	d	56	22.528 to 481.28
-0.25 to +0.5	1/16	e	13	-0.256 to 0.512

Note: In order to obtain both quick receipt of information and high time-resolution near the trigger time, for some time intervals near the trigger time, overlapping data with differing temporal resolutions are transmitted.

4.1.10 TOTAL (MAX) TRIGDAT ALERT TELEMETRY (PER BURST)

The following table documents the total amount of data that can be expected by the ground for a given burst alert across the TDRS link. (Note that some telemetry packets may be lost in transmission and will not be repeated.)

The "Priority" column ranks the various data types and its importance to localizing an active GRB.

Table 4-11: TRIGDAT Records Data Volume Summary (Per Burst)

Record Type	Purpose	Size (bits)	Number OF Messages	Data Volume	Priority
1	Immediate Summary	304	1	304	High
2	Trigger Rates	2128	1	2128	High
3	Background Rates	1968	1	1968	High
4	Calculated Information	496	5	2480	Very High
5	Max Rates	2192	3	6576	High
6	Background Model – 1 / 3	1952	1	1952	Medium
7	Background Model – 2 / 3	1952	1	1952	Medium
8	Background Model – 3 / 3	1952	1	1952	Medium
9	Time History	2128	124	263872	Low

The Total Data Volume at High Priority or above is 13456 bits. The Total Overall Data Volume is 283184 bits. The Number of Alert Telemetry packets is <= 138.

Note: This quantity of data would take approximately 280 seconds to downlink on a 1kbps data channel. There are breaks in providing the data as the GBM waits for more counts/data during the late part of the processing period. It is expected that the last bits of data will be transmitted at approximately 480 seconds (six minutes) after burst detection.

4.2 LAT GENERATED BURST ALERT TELEMETRY

4.2.1.1 Telemetry Packet Definitions

A burst detection meeting the alert criteria will cause the LAT to send data in up to three different alert telemetry packet types:

3. LATTRIGGER (one per burst)
4. LATUPDATE (up to ten per burst)
5. LATCLOSEOUT (one per burst)

For a LAT-detected burst alert, the LATTRIGGER alert telemetry packet shall be sent to the spacecraft within five seconds (with a goal of two seconds) of burst detection for transmission to the ground. The LATTRIGGER alert telemetry is the primary vehicle for ground processing and is described in Table 4-12. Only one Trigger alert telemetry packet is sent per burst.

Because bursts have such a wide range of characteristics, with some displaying very large and delayed energy output, LATUPDATES are provided as alert telemetry packets. The Update Record is described in Table 4-13. The criteria and frequency of LATUPDATE are intentionally left unspecified to allow for flexibility (the high-energy behavior of bursts is one of the large discovery spaces for GLAST). However, the maximum number of LATUPDATE alert telemetry packets per burst alert shall be ten (bursts may have zero LATUPDATE alert telemetry packets).

For every LAT-detected burst alert, LAT shall issue one LATCLOSEOUT alert telemetry packet, as described in Table 4-14. The LATCLOSEOUT shall be issued after a predetermined time period of below-threshold detection (a LAT parameter setting) of at least one minute (or non-detection; this time period is not likely to exceed 10 minutes).

Once a LATTRIGGER telemetry packet is generated, no further LATTRIGGER packets shall be generated until after a LATCLOSEOUT telemetry packet is generated.[2].

[2] One possible exception to this is when the LAT is reset or power-cycled after a Trigger Record has been sent but before the Closeout Record has been sent. GBM and the ground system will probably want to know about such occurrences.

4.2.2 LATTRIGGER

One “LATTRIGGER” Alert Telemetry packet per burst is sent to the SC for transmission to the ground.

Table 4-12: LATTRIGGER Alert Telemetry

LATTRIGGER	**Once per burst trigger, the LAT shall provide this Alert Telemetry to the SC (for transmission to the ground).**	
	Telemetry APID: x341; Length: 88 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 8 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header 32-bit big-endian unsigned int; Seconds since epoch 32-bit big-endian unsigned int; microseconds
	Record Info	Type: 2 bytes, defined as follows: Record version – 4 bits (tbs) Record type – 4 bits (= 1 [Trigger Record]) Record sequence count – 8 bits (Always 0 for this packet)
	Time-seconds	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst). Serves as Burst ID.
	Time-microsec	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst).
	Burst Classification	Type: 4 bytes, defined as follows: Information, e.g., is this a repoint candidate, etc.
	First Location RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	First Location DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	First Error RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984.
	First Error DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Time-sec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-microsec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-sec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Time-microsec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Gammas-0-100-MeV	Type: 2 byte; unsigned int; 0 < N(gammas) < 100 MeV (saturates at xFFFF)
	Gammas-100MeV-1GeV	Type: 2 byte; unsigned int; 100 MeV < N(gammas) < 1 GeV (saturates at xFFFF)
	Gammas-1GeV-10GeV	Type: 2 byte; unsigned int; 1 GeV < N(gammas) < 10 GeV (saturates at xFFFF)
	Gammas-10GeV-up	Type: 2 byte; unsigned int; 10 GeV < N(gammas) (saturates at xFFFF)

	Trig-ParamStat00	2 bytes; content tbs
	Trig-ParamStat01	2 bytes; content tbs
	Trig-ParamStat02	2 bytes; content tbs
	Trig-ParamStat03	2 bytes; content tbs
	Trig-ParamStat04	2 bytes; content tbs
	TrigParamThresh00	2 bytes; content tbs
	TrigParamThresh01	2 bytes; content tbs
	TrigParamThresh02	2 bytes; content tbs
	TrigParamThresh03	2 bytes; content tbs
	TrigParamThresh04	2 bytes; content tbs

4.2.3 LATUPDATE

These Alert Telemetry packets are sent to the ground (but not to GBM). Total size is 88 bytes. A maximum of ten Updates are sent per burst.

Table 4-13: LATUPDATE Alert Telemetry

LATUPDATE	**The LAT shall provide this Alert Telemetry to the SC (for transmission to the ground) as updates to its burst processing are available. No more than ten of these Updates shall be generated per burst ID.**	
	Telemetry APID: x342; Length: 88 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 8 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header 32-bit big-endian unsigned int; Seconds since epoch 32-bit big-endian unsigned int; microseconds
	Record Info	Type: 2 bytes, defined as follows: Record version – 4 bits (tbs) Record type – 4 bits (= 2 [Update Record]) Record sequence count – 8 bits (1 to n)
	Time-seconds	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst). Serves as Burst ID.
	Time-microsec	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst).
	Burst Classification	Type: 4 bytes, defined as follows: Information, e.g., is this a repoint candidate, etc.
	Update Location RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Update Location DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Update Error RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984.
	Update Error DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Time-sec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-microsec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-sec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Time-microsec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Gammas-0-100-MeV	Type: 2 byte; unsigned int; 0 < N(gammas) < 100 MeV (saturates at xFFFF)
	Gammas-100MeV-1GeV	Type: 2 byte; unsigned int; 100 MeV < N(gammas) < 1 GeV (saturates at xFFFF)

	Gammas-1GeV-10GeV	Type: 2 byte; unsigned int; 1 GeV < N(gammas) < 10 GeV (saturates at xFFFF)
	Gammas-10GeV-up	Type: 2 byte; unsigned int; 10 GeV < N(gammas) (saturates at xFFFF)
	Trig-ParamStat00	2 bytes; content tbs
	Trig-ParamStat01	2 bytes; content tbs
	Trig-ParamStat02	2 bytes; content tbs
	Trig-ParamStat03	2 bytes; content tbs
	Trig-ParamStat04	2 bytes; content tbs
	TrigParamThresh00	2 bytes; content tbs
	TrigParamThresh01	2 bytes; content tbs
	TrigParamThresh02	2 bytes; content tbs
	TrigParamThresh03	2 bytes; content tbs
	TrigParamThresh04	2 bytes; content tbs

4.2.4 LATCLOSEOUT

This Alert Telemetry packet is sent to the SC for transmission to the ground once per burst trigger.

Table 4-14: LATCLOSEOUT Alert Telemetry

LATCLOSEOUT	**The LAT shall provide this Alert Telemetry to the SC when it closes its burst processing for the specified burst. No more than one of these Closeout Records shall be generated per burst ID.**	
	Telemetry APID: x343; Length: 88 bytes	
	Packet Header	Type: 6 bytes; CCSDS telemetry packet header See Section 4.8 – 1553 ICD, Instrument CCSDS Telemetry
	Secondary Header	Type: 8 bytes; CCSDS telecommand secondary header - time See Section 4.9 – 1553 ICD, Telemetry Secondary Header 32-bit big-endian unsigned int; Seconds since epoch 32-bit big-endian unsigned int; microseconds
	Record Info	Type: 2 bytes, defined as follows: Record version – 4 bits (tbs) Record type – 4 bits (= 3 [Closeout Record]) Record sequence count – 8 bits (Always 0 for this packet)
	Time-seconds	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst). Serves as Burst ID.
	Time-microsec	Type: 4 bytes; 32 bit big-endian unsigned integer The LAT specified burst “declaration time” (identical in all packets related to the same burst).
	Burst Classification	Type: 4 bytes, defined as follows: Information, e.g., is this a repoint candidate, etc.
	Final Location RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Final Location DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Final Error RA	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984.
	Final Error DEC	Type: 4 bytes; 32-bit float, ANSI/IEEE 754-1984. .
	Time-sec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-microsec-earliest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of earliest photon in the statistics block.
	Time-sec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Time-microsec-latest-photon	Type: 4 bytes; 32 bit big-endian unsigned integer Timestamp of latest photon in the statistics block.
	Gammas-0-100-MeV	Type: 2 byte; unsigned int; 0 < N(gammas) < 100 MeV (saturates at xFFFF)
	Gammas-100MeV-1GeV	Type: 2 byte; unsigned int; 100 MeV < N(gammas) < 1 GeV (saturates at xFFFF)
	Gammas-1GeV-10GeV	Type: 2 byte; unsigned int; 1 GeV < N(gammas) < 10 GeV (saturates at xFFFF)
	Gammas-10GeV-	Type: 2 byte; unsigned int;

	up	10 GeV < N(gammas) (saturates at xFFFF)
	Trig-ParamStat00	2 bytes; content tbs
	Trig-ParamStat01	2 bytes; content tbs
	Trig-ParamStat02	2 bytes; content tbs
	Trig-ParamStat03	2 bytes; content tbs
	Trig-ParamStat04	2 bytes; content tbs
	TrigParamThresh00	2 bytes; content tbs
	TrigParamThresh01	2 bytes; content tbs
	TrigParamThresh02	2 bytes; content tbs
	TrigParamThresh03	2 bytes; content tbs
	TrigParamThresh04	2 bytes; content tbs

5 OPERATIONAL SCENARIOS

There are three different scenarios relating to instruments 'triggering' on a burst. One which would require sharing the TDRS link between the instruments.

5.1 GBM TRIGGER ONLY

For each detected GRB above a specified threshold, the GBM will 'Trigger'. When the GBM triggers, it sends an Immediate Trigger Signal (Section 3.1) to the LAT. It also generates both Telecommands to the LAT and Burst Alert Telemetry messages to the SC on the 1553 bus for immediate telemetering to the ground. The telecommands and telemetry will have APIDs in the range specified in the 1553 ICD.

GBM Detected Burst Trigger

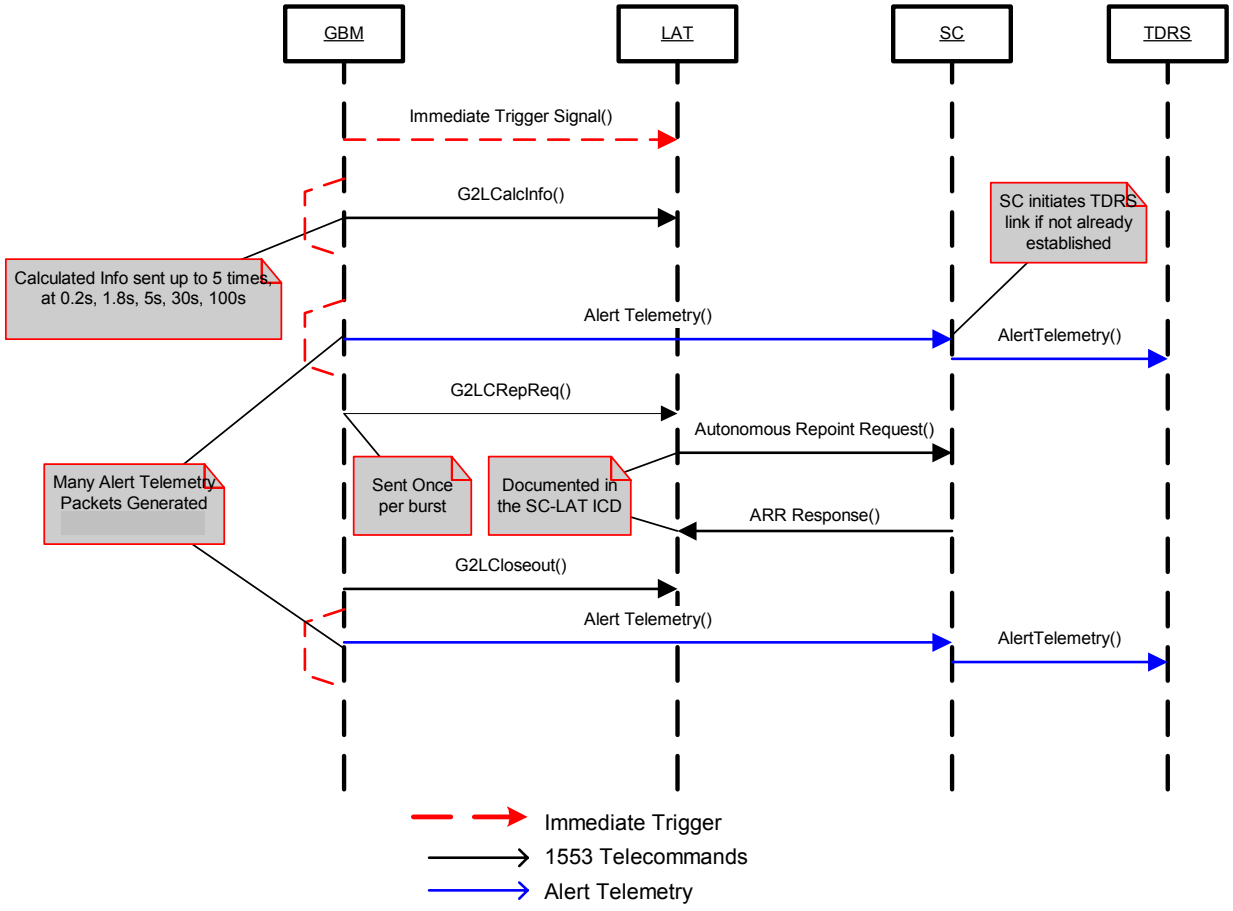

Figure 5-1: GBM Triggers on GRB Sequence Diagram

5.2 LAT TRIGGER ONLY

For each detected GRB above a specified threshold, the LAT will 'Trigger'. When the LAT triggers, it generates Burst Alert Telemetry messages to the SC on the 1553 bus for immediate telemetering to the ground. These messages will be marked with APIDs in the range designated for LAT Alert Telemetry in the 1553 ICD.

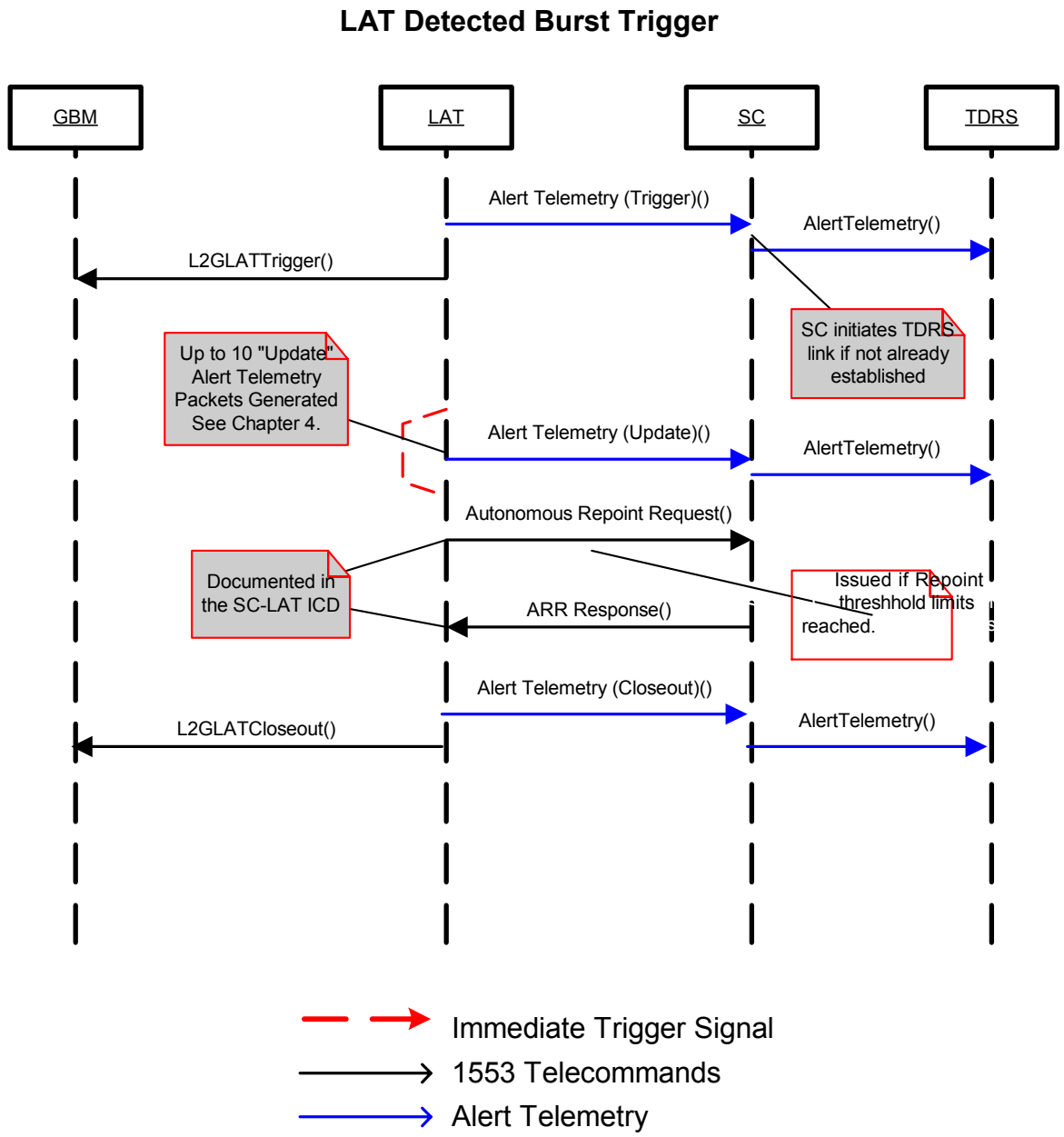

Figure 5-2: LAT Triggers on GRB Sequence Diagram

5.3 GBM & LAT TRIGGER

This diagram assumes the following: The LAT and the GBM trigger on the same GRB. The GBM happens to trigger first.

GBM and LAT Trigger on GRB

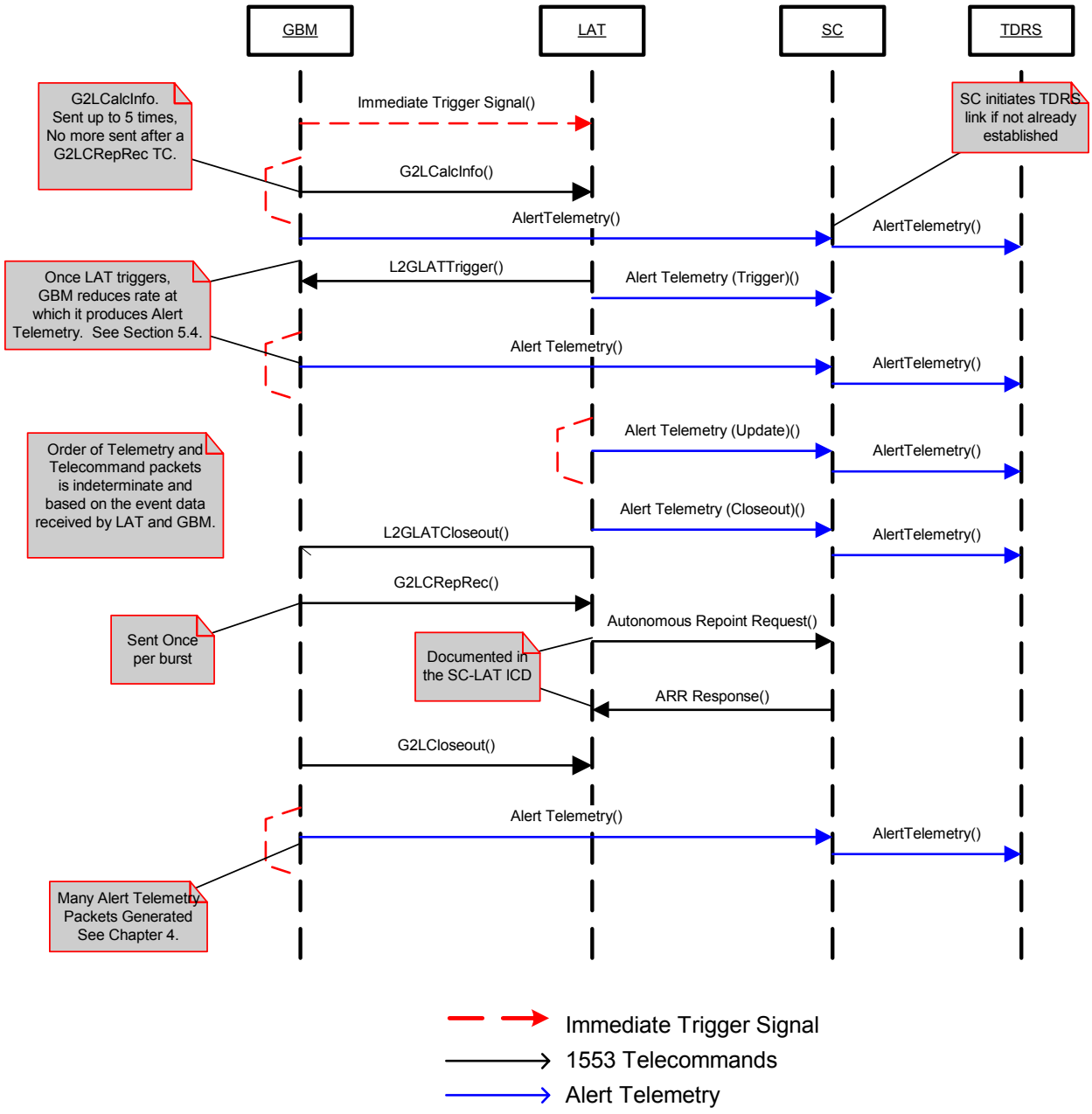

Figure 5-3: Both LAT and GBM Trigger on GRB Sequence Diagram

5.4 DOWNLINK RESOURCE UTILIZATION

During GRBs detected by both instruments, the downlink resource shall be shared.

While processing GRBs, it is recognized that resource contention could exist on the 1kbps TDRS MA return link. To ensure that the most important Alert Telemetry packets arrive on the ground in a timely manner and avoid lengthy delays in transmission in a downlink queue on the spacecraft, both the LAT and the GBM plan to limit the amount of data produced and the rate at which it is transmitted to the spacecraft.

Requirements derived from this utilization sharing for each instrument are in the respective instrument FSW Requirements Specification. (For LAT: LAT-SS-00399 – LAT FSW Requirements Specification; For GBM: GBM-REQ-1019 – GBM Flight Software Requirements Specification.

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